REFERENCE MODEL

A NON-GOVERNMENT ORGANIZATION (NGO)
FOR
SPACE STATION UTILIZATION MANAGEMENT

Discussion Draft

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"K.E. Tsiolkovsky once wrote: 'The idea, fantasy, or fairy tale invariably comes first. Following this is the stage of scientific investigation. Last comes the crowning achievement of the idea'. From this undoubtedly accurate summarization we need to extract the concept of 'scientific investigation' and examine it more carefully. It is not as easy as it would first appear. Regarding the first step -- the idea, fantasy, or fairy tale -- everything is clear. Man has always dreamed of achieving the unattainable (and still does today). Without dreams and the efforts made to attain them progress would be unthinkable. Even if the dream is initially unattainable, this does not mean that it may never be realized. Although harsh reality may intervene repeatedly to prove the impossibility of realizing the dream as yet, reality cannot force people to forget or discard it. Instead the dream is transferred to an original data bank: the fairy tale. There it lives on, continually reminding people of its existence, seeming to await the time when its realization will no longer be impossible.

A more complicated matter is that which Tsiolkovsky called 'scientific investigation.' This stage begins when the general development of scientific knowledge has reached a level of sophistication sufficient to allow someone to appear who is able to envision a way of realizing the dream (very often it is several people who live far apart and who work independently of one another). During this stage the dream begins to move towards reality, but it does not go beyond the discovery that what everyone has heretofore considered an unattainable -- and therefore empty -- dream is in fact possible after all."

from Herman Oberth: The Father of Space Flight
Boris V. Rauschenbach, 1994

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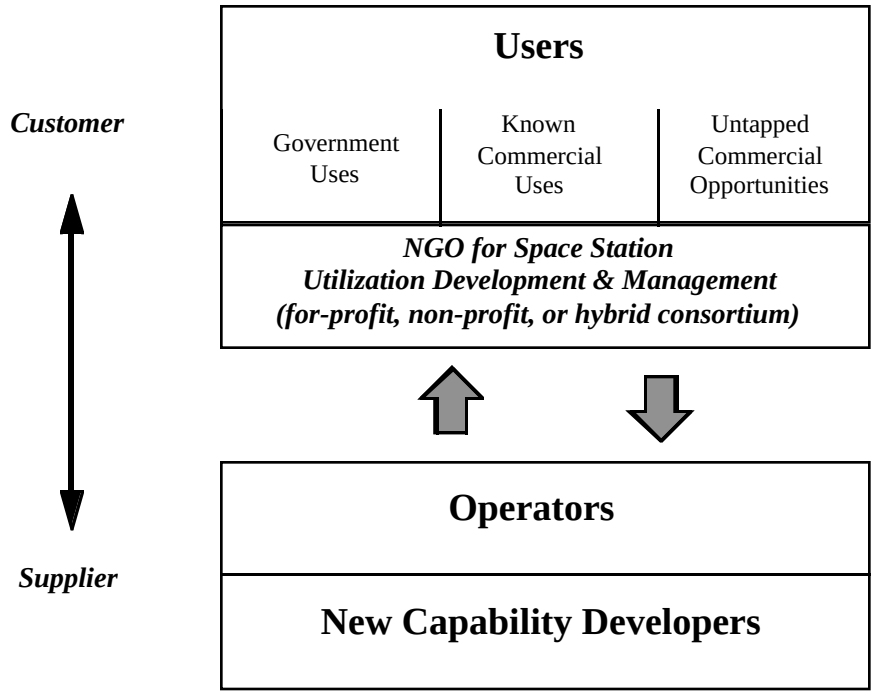
The purpose of this reference model is to initiate a discussion of a new management approach to R&D in low-earth orbit consistent with the present and future constrained budget challenges. The objective is to create a non-government organization (NGO) for accomplishing an aggressive science, technology and commercial development program while simultaneously limiting government functions to policy and oversight.

The ultimate success of the orbital R&D program depends equally on the efficient operation of the space and ground assets (laboratories, spacecraft, space station...) and on the optimal utilization of the assets by the R&D and business communities. The utilization component must be managed in a manner which ensures productivity of the space station and other future ground and space assets. As depicted below, a NGO would serve as the interface between users and operators, in order to maximize the range of productive uses, as well as minimize the cost and schedule associated with conducting user operations in low-Earth orbit

The framework for a NGO should be based on a management structure that is representative of, and responsive to, a broad base within the utilization community. This management structure must possess a high degree of stability that will permit it to undertake and complete an integrated program over the expected life of the space station and associated assets.

Establishing the Customer - Supplier Relationship



VISION

- A dedicated NGO that will develop the low Earth orbit environment for all users (scientific, technological, and commercial), in order to more efficiently advance scientific knowledge, technological capability, and commerce on Earth as a gateway to 21st Century exploration and development of space.

GOALS

1. Complete an operational concept and establish a NGO in the United States by FY 2000.
2. Employ the NGO to reduce the cost and schedule associated with payload operations in space.
3. Employ the NGO to revolutionize the approach to research, exploration and development of space through increased academic cooperation and industrial collaboration.
4. Offer to expand the initial organization to accommodate international aspects in conjunction with completion of the International Space Station.

PRINCIPAL PURPOSES

1. Engage the science community in a cooperative endeavor to aggressively expand the scientific foundation for human exploration and development of space.
2. Engage the engineering community in a collaborative endeavor to aggressively expand the technological capability of the International Space Station and enable future human exploration and development of space.
3. Engage the space operations community in a revolutionary transition toward cheaper, better and quicker access to space for the conduct of R&D and commercial endeavors.
4. Disperse information on the resulting scientific and technological achievements for the benefit of life on Earth, while stimulating the commercial community to expand the global economy in space products and services.

WORKING PRINCIPLES

(a) <u>Scope of R&D Program Management</u>

- The scope could include all R&D projects which utilize a US share of the International Space Station.
- Collaborating and supporting research using other NASA ground, air, and space assets could be included by written agreement.
- Basic and applied, flight and ground, research in science and technology could be pursued with strategic direction in selected areas such as, but not limited to:
    - biology, chemistry and physics
    - medical research and applications

- environmental sciences and life support technologies
- spacecraft system, subsystem and component engineering
- space processing of materials
- biotechnology
- remote sensing
- communications

- The scientific research program could be managed by the NGO and the research projects could be conducted by distributed laboratories, institutes, and research and development facilities in the academic, industrial, and government sectors.

- The technology development program could be managed by the NGO and the development projects could be conducted by distributed laboratories, institutes, and research and development facilities in the academic, industrial, and government sectors.

(b) Scope of Commercial Program Development

- Proof-of-concept or full-scale private commercial projects could be administered by the NGO in accordance with national policy.
- The policy could include specific provisions to address totally subsidized, partially subsidized, and non-subsidized entrepreneurial endeavors.
- A value-based pricing schedule could be established during the early operations period, with a transition to cost recovery when commercial enterprises become profitable.
- In the event recovery of public operating costs prohibits profitable operations, or the supply of station accommodations is exhausted, commercial enterprises could relocate to privately owned and operated space platforms.

(c) Role in Space Exploration

- The NGO could undertake R&D projects, sponsored by NASA, with applications to the human exploration and development of space enterprise.

(d) Program and Project Funding

- Funds could be provided by both public and private sources.
- Public sources could include government agencies which serve as catalysts, such as, but not limited to, NASA.
- Private sources could include philanthropies, industrial organizations, university/industrial consortia, financial institutions, and venture capitalists.

- A privately managed space trust corporation could be created to operate in close association with the NGO, in order to assist in the evaluation and financing of entrepreneurial ventures.

(e) Program and Project Opportunities

- Scientific and technological R&D opportunities, which are funded through public monies could be announced on a regular periodic basis and could be open to competition among academic, industrial and government scientists and engineers world-wide.
- Commercial opportunities could be open on a continuous basis for proposals by private organizations.
- Since the magnitude of opportunity will be constrained by available station resources and accommodations, an allocation policy could be established by the NGO Board of Directors.

(f) Program Integrity and Project Selection

Scientific Research:

- Projects could be externally peer reviewed to the highest standards and rated, prior to selection by the NGO Science Program Office based on scientific merit.
- The selections would conform to the programmatic objectives and funding levels of the respective sponsors.

Technology Development:

- Projects could be internally reviewed by the NGO Technology Program Office and selected based on engineering feasibility.
- The selections would conform to the programmatic objectives and funding levels of the respective sponsors.

Commercial Ventures:

- Projects could be administered by bonded personnel in the NGO Commercial Program Office.
- Selection criteria could vary with the level of public subsidization.
- Non-subsidized ventures could be selected on the basis of the magnitude of private capital at risk; partially subsidized ventures could be rated by the ratio of private-to-public funding, and; fully subsidized ventures could be selected at the discretion of the government sponsor.

- The NGO could be required by the Board of Dirctors to administer a portfolio with minimum shares in each of these categories.

(g) Notification of Project Awards

- The NGO could issue formal notifications of award, subject to the principles on program integrity and project selection.
- In cases of commercial ventures, with private funding, notifications could be confidential by prior request.

(h) Distribution of R&D Project Awards

- Funds could be allocated for award to both NGO-resident (e.g., 10%) and non-resident (e.g., 90%) scientists and engineers on a competitive basis.

Open Item: do the advantages associated with some degree of resident R&D outweigh the disadvantages?

Advantages include:

(1) the ability to attract a high-quality, professionally recognized science and engineering staff;

(2) the ability of the resident NGO staff to work at a peer level with the non-resident R&D community and to serve a "smart buyers";

(3) the increased professional credibility of the NGO; and

(4) the incentive created by broadening the NGO's scope of operations to include resident R&D.

Disadvantages include:

(1) the potential appearance, or actual existence, of a conflict of interest in the resident and non-resident R&D award process.

(i) R&D Results

Proprietary Results:

- All R&D results and information could be the property of the funding source and handled without public disclosure, as addressed through binding agreement among the parties.

Non-Proprietary Results:

- All research results could be treated as within the public domain.
- Every research project awarded would be required to conform to the data policy of the funding source.
- All reports could be archived at the NGO and available on-line through international telecommunications networks.

(j) Resident Staff

- Resident staff could be representative of the core science and engineering disciplines with visiting senior scientists and engineers in selected specialties.
- All visiting staff could be fully authorized to make decisions and enter into agreements on the behalf of their home institutions.
- Options for a government presence could include a liaison office limited to on-site representatives of the program sponsors, or visiting Senior Scientists and Engineers.

(k) Project Scientists and Project Engineers

- Every R&D project could include the designation of a resident NGO staff member as Project Scientist or Project Engineer.
- The role of the NGO Project Scientists and Engineers could be to assist non-resident flight research projects through the steps associated with physical, analytical, and operations integration of flight research projects.

(l) Research Facilities

- The NGO could be based in a physical facility (public or private) with either on-site, or geographically dispersed, laboratory assets, or both.
- It could employ state-of-the-art international telecommunications networks for communications with associated organizations from either the public or private sectors.

(m) Laboratory Assets

- Existing government assets could be transferred to the NGO for management or made available through negotiated agreement.
- These assets could include both space and ground-based facilities.
- Development of new assets, including flight instruments and facilities, could be performed by the NGO or placed under NGO management.

(n) Payload Physical, Analytical, & Operations Integration

- Functions could be performed by the NGO, or a mission support contractor to the NGO.
- Orbital real-time operations replanning could be performed by the space station operator in cooperation with a Mission Director and R&D Working Group assigned by the NGO.
- The NGO could perform all tactical planning for R&D operations on flight and ground systems.

(o) Organizational Interfaces

- The NGO could interface with public and private funding sources for space station related policy, oversight and strategic direction;
- with the space station operator (public or private) for payload accommodations and system operations integration;
- with world-wide academic, industrial and government organizations for space station R&D project performance;
- with private organizations for commercial ventures, and;
- with an external advisory committee for independent annual review.

(p) Instruments of Agreement

- Agreements between the NGO and associated organizations could be established through a variety of instruments and would be limited only by public law.
- These instruments could be tailored on a case-by-case basis to best protect the interests of the parties.
- The instruments could include, but would not be limited to:

• memoranda of agreement	• memoranda of understanding
• terms of reference	• cooperative R & D agreements
• contracts	• space system development agreements
• grants	• industrial guest investigator agreements
• joint endeavor agreements	• intergovernmental personnel agreements

(q) Program Planning

- The NGO could develop projections of available orbital accommodations and resources based on information supplied by the space station operator.
- The NGO could formulate options for accommodating research requirements, maintain a dynamic Mission Model, and produce an annual one-year R&D Program Plan and an annual one-year Commercial Prospectus.
- The Plan and Prospectus could be reviewed and approved by the NGO Board of Directors at an annual meeting.
- The annual Plan and Prospectus could be formulated within the broader context of the funding sponsors' long-term strategic plans and commitments.

(r) Board of Directors

- The NGO board could include academic, industrial, and government directors.

- Voting shares on the board could correspond to annual funding commitments of the sponsoring directors.
- The Board could ensure the NGO operates in accordance with its charter and within the policy established by the sponsoring directors.

(s) Accountability

- The NGO could produce quarterly reports on cost, schedule and performance status for every active R&D project and an annual report on achievements for every active R&D program.
- All reporting could be subject to proprietary information restrictions.
- The quarterly and annual reports could be the primary products delivered to the funding sponsors (e.g., NASA, or other public and private program sponsors).

(t) Advisory Committees

- An independent external advisory committee could perform periodic independent reviews of NGO progress and achievements.
- In the case of the United States, independent advice and guidance could also be provided by the standing boards and committees of the National Research Council.
- The NASA Advisory Council, and its standing committees and subcommittees, could perform periodic reviews at the request of the NASA program sponsoring offices.

(u) Educational Responsibilities

- The NGO could include a dedicated Education Office with responsibility for communicating the beneficial attributes of the orbital environment and the progress of the R&D program to public and private audiences at all levels in the academic, government and industrial sectors.
- The costs associated with this function could be funded by the space station owners and operators.

(v) Criteria for Institute Site Selection

- Criteria could include,
    - availability of existing facilities and skilled personnel;
    - geographic attractiveness for personnel relocation;
    - easy access for program sponsors and project managers;

- potential for evolution to international operations;
- association with an internationally recognized university;
- support of the local and state governments; and
- proximity to advanced telecommunications resources.

APPENDIX

TERMINOLOGY

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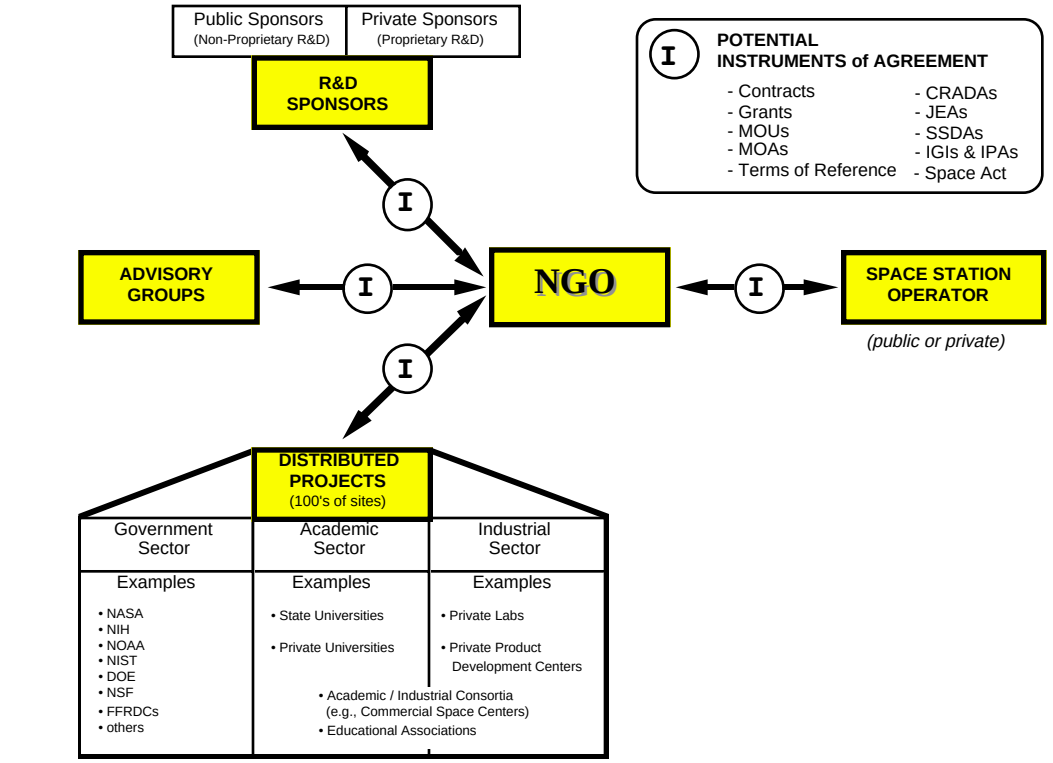
10/09/98



TRANSACTIONS

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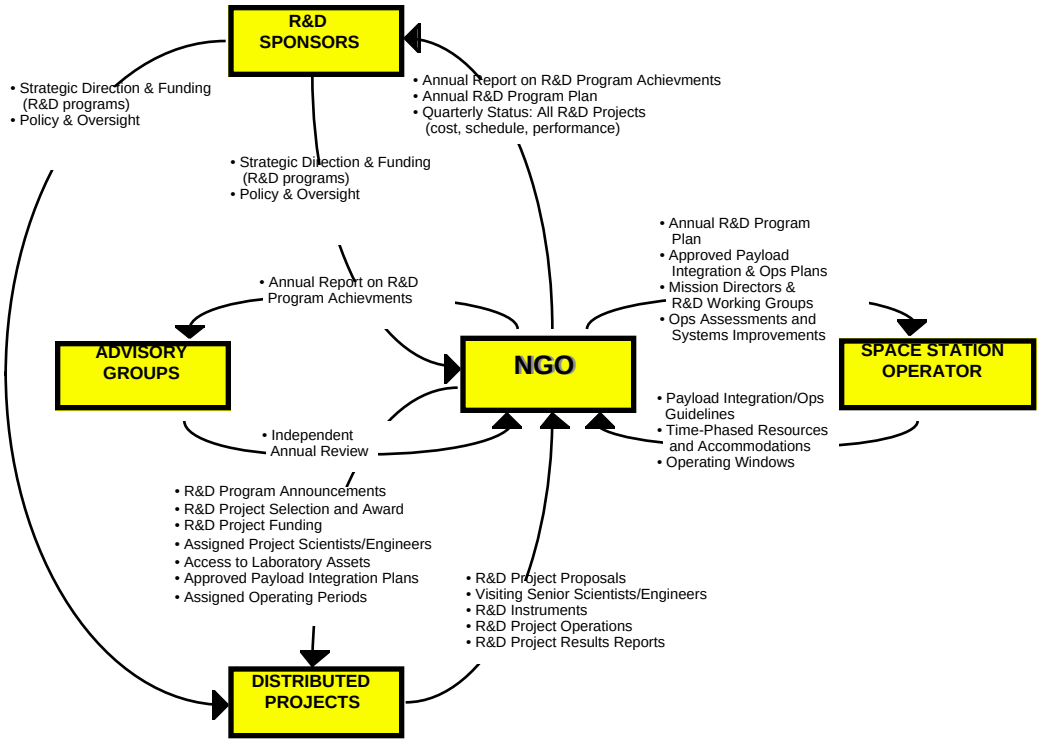

ORGANIZATION

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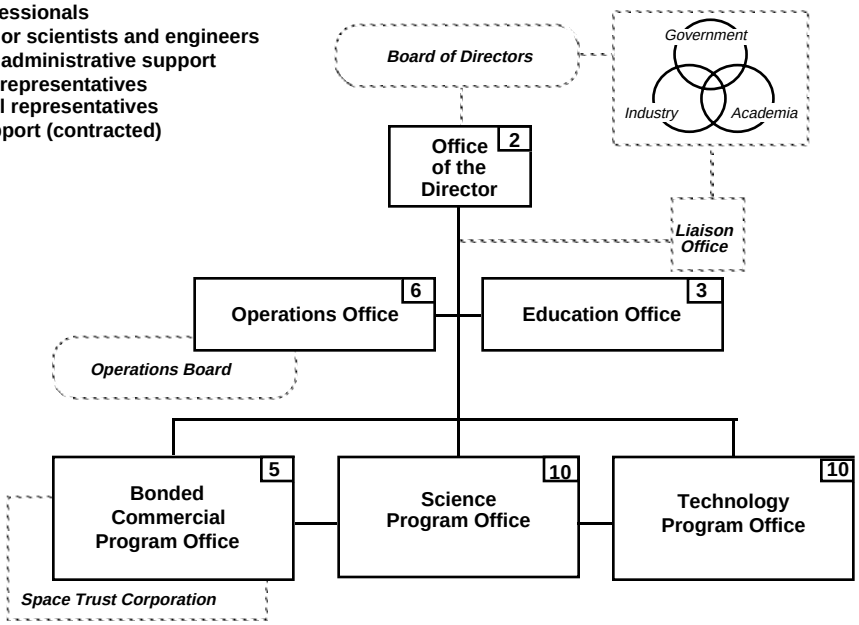
36 **Resident Professionals**
+ visiting senior scientists and engineers
+ clerical and administrative support
+ sponsoring representatives
+ international representatives
+ mission support (contracted)



• Commercial Operations **• Science Operations** **• Technology Operations**

FUNCTIONS

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Office of the Director
- selected by the Board of Directors
- utilization program development
- management and administration

Board of Directors
- annually reviews & extends research programs
- communicates policies of the sponsoring organizations
- approves Annual R&D Program Plan and Commercial Prospectus

Liason Office
- staffed by national and international program sponsors
- represents sponsors and provides oversight

Education Office
- develops collateral products for education
- communicates attributes of orbital environment and achievements of the R&D programs

Operations Office
- strategic, tactical, and contingency planning
- manages resource allocations & mission model
- manages mission support contract
- produces annual R&D Program Plan and annual Commercial Prospectus

Operations Board
- selects Project Scientists & Engineers for residency
- approves visiting Senior Scientists & Engineers
- assigns Mission Directors and R&D Working Groups
- approves payload integration plans & flight assignments
- assigns operating periods & accommodation sites

Science Program Office
- scientific research program management
- conducts nominal share of scientific research
- establishes science project queue
- defines requirements for flight instruments
- procures/develops flight instruments
- manages analytical, physical and operations integration
- manages science results archive

Technology Program Office
- technology development program management
- conducts nominal share of technology development
- establishes technology project queue
- defines requirements for flight equipment
- procures/develops flight equipment
- manages analytical, physical and operations integration
- manages technological results archive

Bonded Commercial Program Office:
- implements commercial policy of government sponsors
- liaisons to private sector and Commercial Space Center network
- establishes commercial project queue
- manages analytical, physical and operations integration
- maintains proprietary procedures and protocols

Space Trust Corporation
- manages private capital funds
- selects private ventures for funding with equivalent rigor to private capital markets
- finances qualified private ventures, if necessary

RESPONSIBILITIES

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NASA	NGO
Headquarters	
STRATEGIC NASA R&D PROGRAM PLANNING: • Strategic direction and funding of R&D programs. • Policy formulation. • Oversight of NGO.	**STRATEGIC SPACE STATION UTILIZATION PLANNING** • Strategic utilization planning for science, technology and commercial programs/projects. • National & International collaboration and coordination for scientific research and technology development programs. • Integration of station-wide utilization requirements. • Definition and assignment of orbital operating periods to R&D projects. • Mission modeling, resource allocation, and bartering. • Utilization advocacy and education.
Field Centers	
R&D PROJECT MANAGEMENT • specific NASA projects	**SPACE STATION UTILIZATION PROGRAM MANAGEMENT** • station-wide management integration for US programs. • US interface to international partner utilizationprograms for mission integration.
DEVELOPMENT • Manage and conduct design, development, test, and evaluation of advanced spacecraft system projects for NASA Enterprises. • Manage and conduct design, development, test, and evaluation of current space station payload facility class hardware, through to completion and on-orbit test and verification.	**DEVELOPMENT** • Manage development of requirements and specifications for next generation government sponsored payload hardware. • Manage design, development, test and evaluation of future government sponsored payload elements. • Develop recommendations for flight/ground system improvements.
OPERATIONS & MAINTENANCE (potential GO-CO elements) • Manage safe operation and maintenance Space Shuttle and International Space Station. • Manage safe operation and maintenance of government ground-based laboratories, control centers, and facilities.	**OPERATIONS & MAINTENANCE** • Manage payload flight / ground systems operations & maintenance. • Manage payload analytical, physical and operations integration. • Represent US interests in international forums and provide Mission Director(s) and R&D Working Groups. • Develop requirements for payload crew skills and qualifications. • Manage payload data processing, data distribution, and results archiving.
HUMAN RESOURCES (potential GO-CO elements) • Maintain occupational safety and health of flight crews and ground personnel. • Manage & conduct training of flight crews and ground personnel.	

STAKEHOLDER VETTING

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